Air Force Research Laboratory's Focused Long Term Challenges

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ABSTRACT

The Air Force Research Laboratory (AFRL) mission is to provide support to the Air Force (AF) and the warfighters with an understanding of the science and technology that will form the foundation of future capabilities. AFRL has developed a strategic research and development process that translates the Department of Defense future capability needs into mid-term attributes, described in terms of technology achievements. Specific capabilities, like the delivery of a close-in sensing platform, require technologies from many different disciplines and require aligning priorities for nurturing and developing core competencies. AFRL's strategic vision is built upon the AF Science & Technology (S&T) Vision of Anticipate, Find, Fix, Track, Target, Engage, and Access – Anything, Anywhere, Anytime. In order to realize this vision, AFRL has developed Focused Long Term Challenges (FLTCs) that describe the AF problem space and constitute the AFRL long term S&T planning.

Keywords: Research and development, long-term technology planning, science and technology, AFRL vision

1. INTRODUCTION

Although AFRL maintains a diverse technology portfolio to achieve the AF S&T vision, there are far more warfighter requirements that need to be addressed than funding will allow. There are national strategic S&T needs, major warfighting command priorities, and product center S&T challenges, to name a few, that all demand technology investment. With limited resources (both funding and people), a balanced approach to satisfying all the S&T needs of the various customers who rely on AFRL for technology development must be taken. The method AFRL has taken to solve this investment challenge is an integrated capability-based planning and programming (Figure 1) approach.

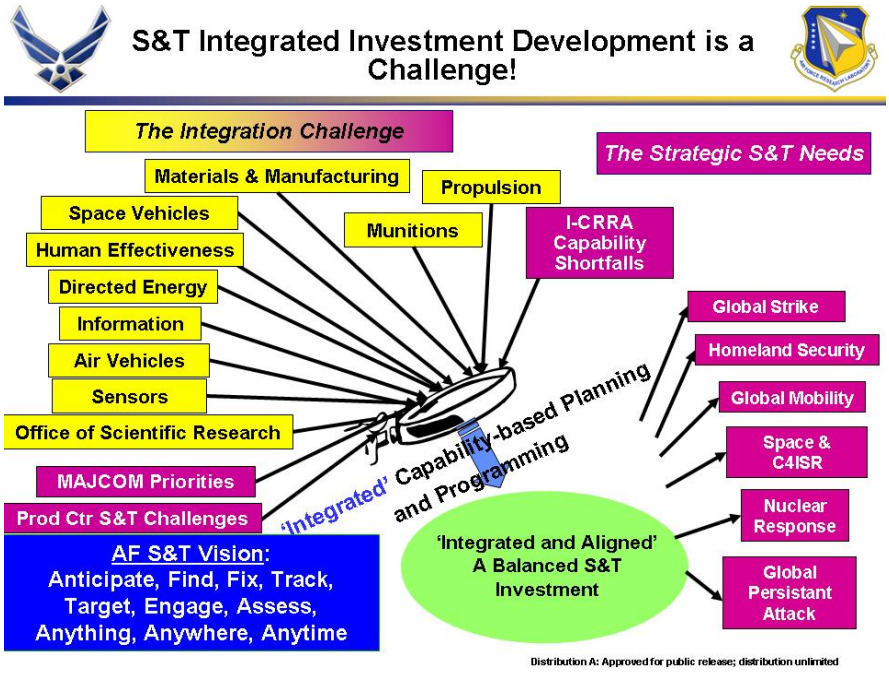

Fig. 1. Integrated Investment Challenge.

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AFRL is made up of ten Technical Directorates: Office of Scientific Research, Sensors, Air Vehicles, Information, Directed Energy, Human Effectiveness, Space Vehicles, Materials & Manufacturing, Munitions, and Propulsion. Each Directorate focuses on specific core technical competencies, and combined, they cover the three domains of air, space, and cyber.

1.1 Air Force S&T Vision

"The Air Force has recently adopted a new technology vision – Anticipate, Find, Fix, Track, Target, Engage, Assess – Anything, Anywhere, Anytime. This technology vision, which was born in our Air Force Research Laboratory, builds on the Air Force's traditional kill chain construct by focusing it on the technology challenges presented by the Global War on Terrorism. It provides a tight link to the Air Force's capabilities-based planning and Capability Review and Risk Assessment (CRRA) processes. Our proactive program guidance ensures the Air Force S&T Program meets the capability needs of today's warfighter, while maintaining investments in those technologies that will ensure technological superiority and avoid technological surprise in the future.[1]". This S&T Vision is integrated across the three domains – Air, Space, and Cyber – and is focused on elimination of any capability gaps that may develop due to the changing dynamics of the world (Figure 2).

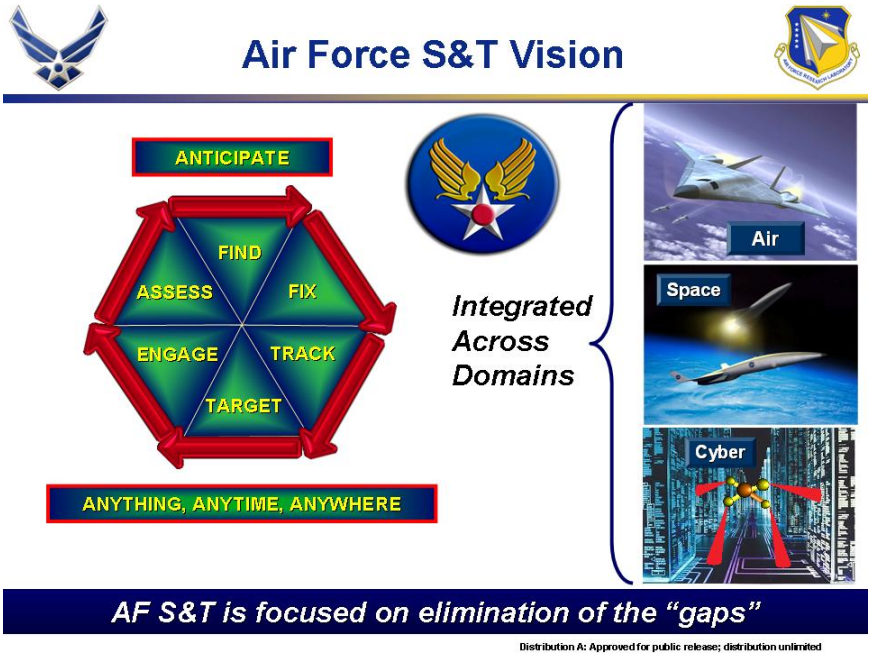

Fig. 2. Air Force S&T Vision.

1.2 AF Needs

In addition to the three integrated domains, the research, development, and testing of new capabilities must be time-phased to meet the demands of the quickly evolving defense front. First, rapid reaction to immediate warfighter gaps is critical to keeping the US on the offensive in the global war on terrorism (GWOT). AFRL must rapidly deliver technical innovations which are driven by the warfighter's emergencies. This immediate response is known as Rapid Reaction and they reshape today's battles. The next time-phased needs stem from next generation requirements, product improvements, and testing of mature technologies. These developments provide technology options that meet the needs in the near-term and are known as Advanced Technology Demonstrations (ATDs). They shape today's Air Force. The final timed needs are long view strategic planning processes that look beyond the current thinking of the battlefield. Basic research is conducted today to provide an innovative capability in the future (Figure 3). The Focused Long Term Challenges (FLTCs) enable AFRL to describe future capabilities and help develop a technological path that will shape the future Air Force. The FLTC process provides the planning construct to relate future priorities by describing the problems needing to be addressed as opposed to the specific technology solution to pursue.

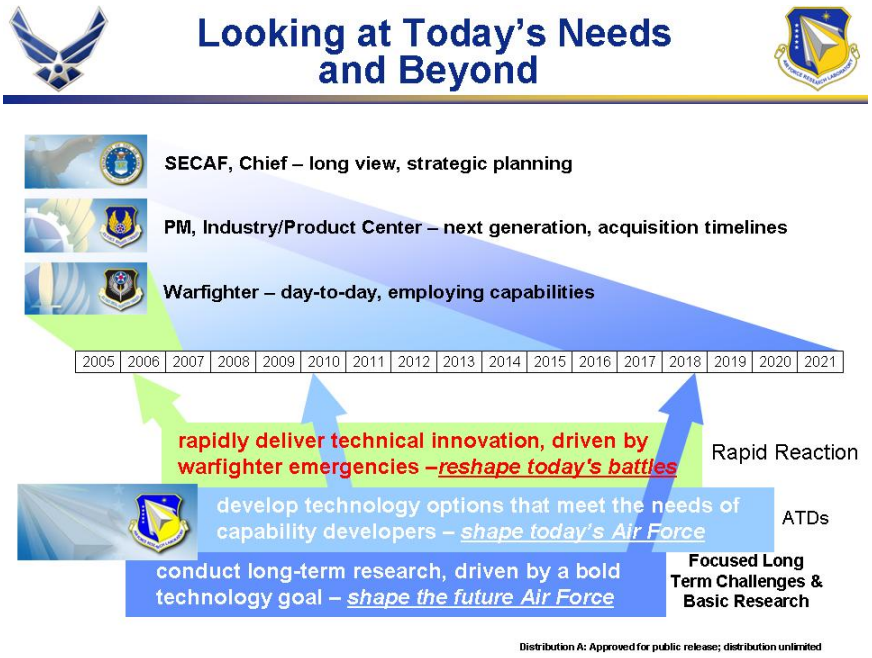

Fig. 3. AF Needs.

1.3 Technical Challenges

Generally speaking, the US has failed in the past to recognize up front how the changing face of our enemy impacts the application of airpower. As stated many times, we will fight the next war like we fought the last. "For example, we saw in Vietnam the limitations of strategic bombing against an enemy with few strategic centers of gravity (at least those we were permitted to strike). In the end, we adapted and the B-52 was quite effective in the close air support and interdiction role. Likewise, planning for the DESERT STORM air campaign was originally built upon this interdiction/CAS model until the Checkmate strategists won support for INSTANT THUNDER. This plan incorporated initial parallel attacks using precision engagement to kick the door down and disable the Iraqi command and control net and air defenses, leaving the forces in the field nearly defenseless against further bombardment. Today, we also recognize that the enemy has changed. And so must the application of airpower, as we now focus on the interdependent warfighting environment to battle insurgents and terrorists who operate without borders, without command and control networks as we know them, and with adaptive and low tech methods.[2]"

The technical challenges that face the AF today can be divided into three main groups: (1) persistent tactical intelligence, surveillance, and reconnaissance (ISR), (2) data fusion into a common operating picture, and (3) rapid, precise, tailorable strike. Persistent tactical-level ISR is the ability to gather and understand enemy characteristics day or night, during any weather conditions, and real-time. The information gathered will be continuous over a city-wide or even theater-wide geographic area. The integration of this data from multiple platforms and sources into a common operating picture will enable the warfighter to strike time-critical targets with an appropriate level of response. The final technical challenge centers around the ability to carry out calculated strikes in minutes or seconds, and the ability to tailor these strikes to urban or cluttered operating environments causing minimal collateral damage. The FLTC process simplifies the strategic planning process by capturing these technological challenges into understandable attributes or capabilities.

Capabilities result from combinations of technologies, systems, connectivity, operating procedures, doctrine, training, leaders, and personnel. Discrete, tactical capabilities are designed from the ground up, with all of these pieces serving as parts of the whole. Large, operational capabilities are achieved through horizontal and vertical integration, as well as interoperability and interdependence of forces, processes, agencies, and materiel. Some capabilities achieve purpose only when combined with others, while some have purpose standing on their own.[3]

2. FOCUSED LONG TERM CHALLENGES

2.1 Overview

To develop game changing air, space and cyber technologies for the AF, AFRL adopted the S&T Vision of "Anticipate, Find, Fix, Track, Target, Engage, Assess, Anything, Anywhere, Anytime" (AF2T2EA4) and is intended to facilitate thinking outside the box in defining game-changing capabilities. The capability to anticipate actions and deliver effects against anything, anywhere and anytime will be central to the US's ability to engage targets in the Global War on Terrorism (GWOT), address Weapons of Mass Destruction (WMD), and minimize the cyber and directed energy threats of today and in the future.

To achieve this AF Vision of AF2T2EA4, AFRL developed 8 FLTCs, using its capability-based planning process. The capability-based FLTC process further aligns the AF and AFRL's support of to the warfighter in planning and programming creative solutions to the future threats and challenges. The 8 FLTCs are (Figure 4):

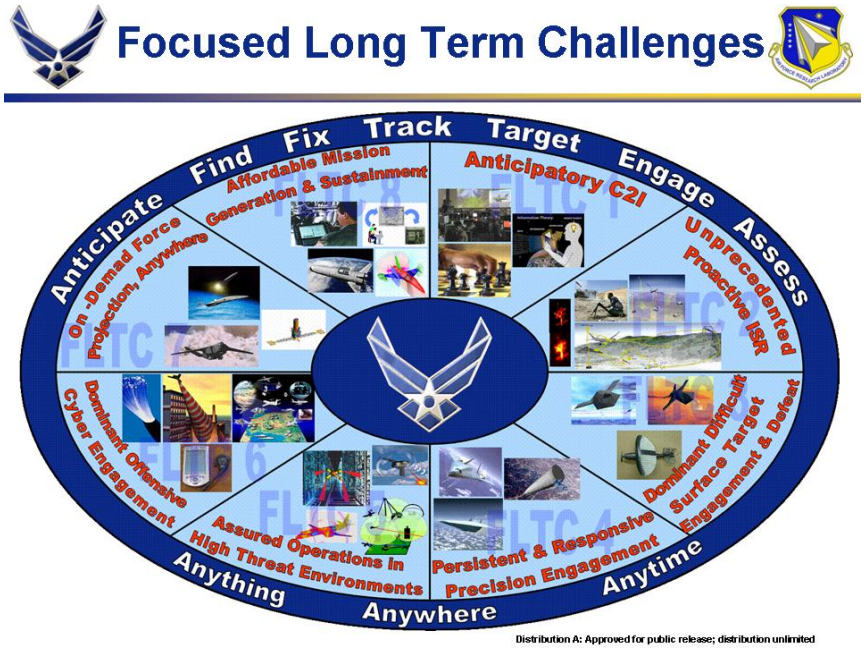

Fig. 4. AFRL's FLTCs.

FLTC #1, Anticipatory Command, Control and Intelligence (C2I), is focused on being inside an adversary's observation, orientation, decision, action loop to enable the ability to predict behavior/anticipate action before it occurs so that it can be shaped and engaged quickly and decisively on our terms (Figure 5).

Fig. 5. FLTC #1.

FLTC#2, Unprecedented Proactive Surveillance and Reconnaissance, is focused on the ability to continuously detect, track and ID critical threats to anticipate and deliver effects anywhere, including within an anti-access environment (Figure 6).

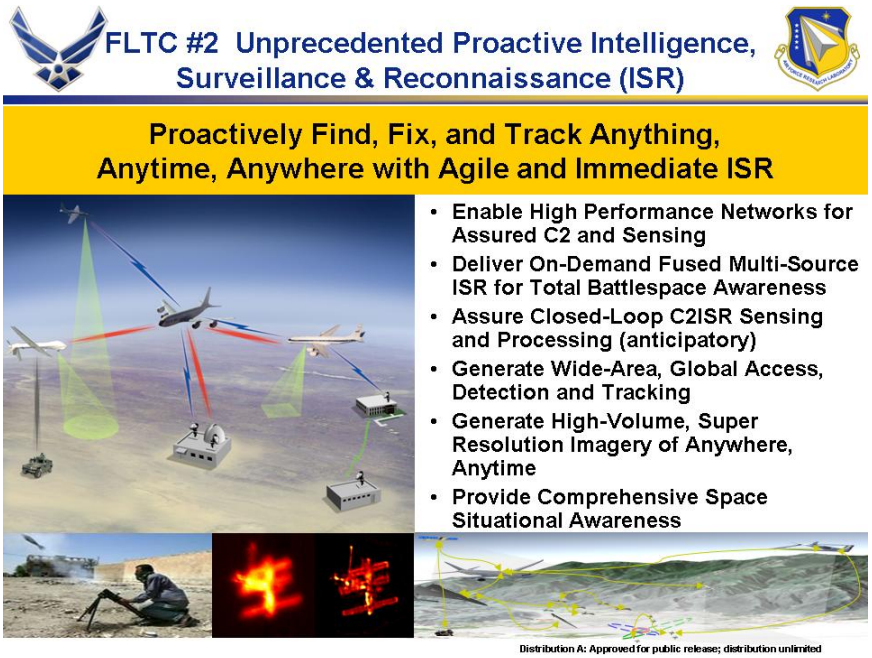

Fig. 6. FLTC #2.

FLTC #3, Dominant Difficult Surface Target Engagement/Defeat, is focused on the ability to deliver selectable and scaleable non-lethal or lethal effects against adversaries and/or their support activities, improvised explosive devices (IEDs), and CBRNE threats in an urban warfare environment (Figure 7).

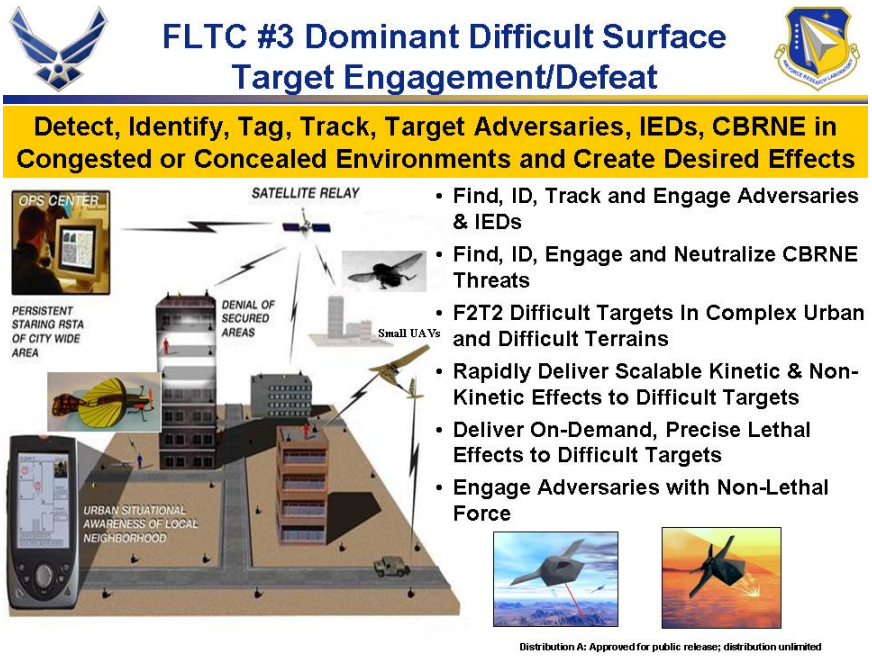

Fig. 7. FLTC #3.

FLTC #4, Persistent & Responsive Precision Engagement, is focused on the ability to precisely place effects against threats around the world in a matter of minutes and hours, and persistently apply force in an anti-access environment (Figure 8).

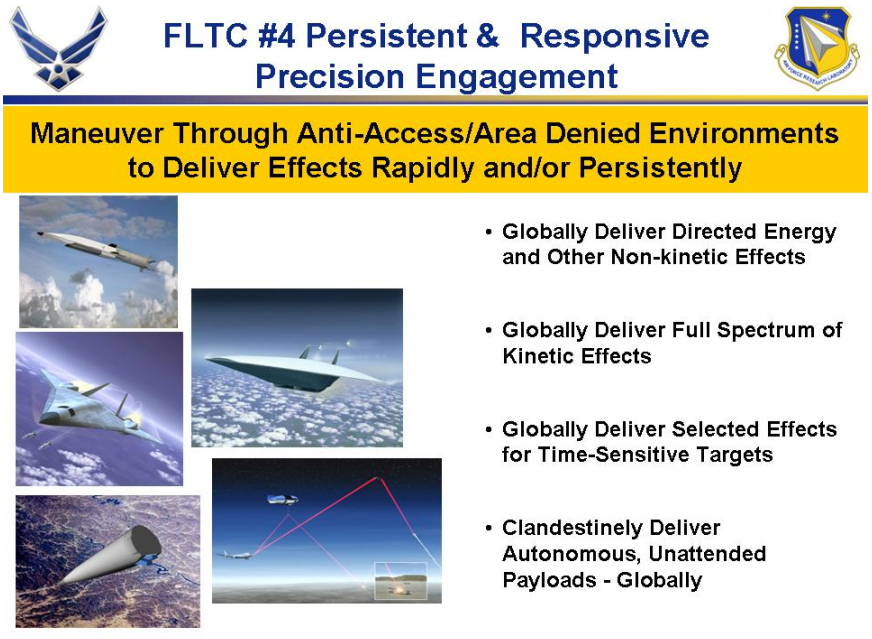

Fig. 8. FLTC #4.

FLTC #5, Assured Operations in High Threat Environments, is focused on defending/protecting ourselves from the traditional as well as the effects of engagement with the disruptive, catastrophic and irregular threats -- survive to fight (Figure 9).

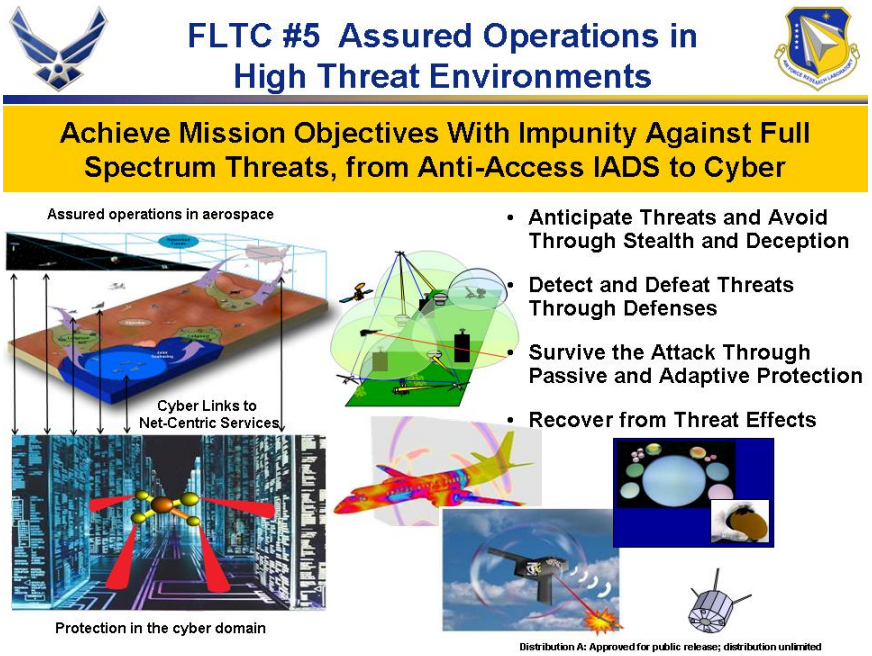

Fig. 9. FLTC #5.

FLTC #6, Dominant Offensive Cyber Engagement, focuses on our ability to engage adversaries through offensive cyber operations (Figure 10).

Fig. 10. FLTC #6.

FLTC #7, On-demand Theater Force Projection, Anywhere focuses on transporting air, space, and cyber capabilities to the operational and tactical warfighter with revolutionary improvements in efficiency and responsiveness (Figure 11).

Fig. 11. FLTC #7.

FLTC #8, Affordable Mission Generation & Sustainment, is focused on revolutionary approaches to sustaining AF air and space systems, both for today and tomorrow. It incorporates integrated system health management, component and system response to operational usage, advanced repair, and maintenance techniques (Figure 12).

Fig. 12. FLTC #8.

2.2 FLTC Process

The FLTC process enables the S&T community to breakdown the broad long term challenge expressed in a particular FLTC into a set of integrated system level experiments and/or demonstrations. Tied together, the experiments / demos relate directly to a mid-term attribute or warfighter capability. So without discussing the details of the technologies necessary to achieve a particular capability, AFRL can now communicate with its customers in a language they understand – warfighting potentials. This is a very powerful planning tool for both the technologists and the warfighter.

From the perspective of the warfighter, he can clearly see what the investments made today will produce and how those demonstrations influence his future tactics and concepts of operations. From the perspective of the technologist, he can now lay out a research and development plan that shows how the investments made today will result in maturing a technology in the near future and how those technologies satisfy an operational need. The integrated demonstrations can be made up of basic research, on-going technology development, and system-level engineering, which are the three basic stages of maturing technology. Combining the various research and development projects in a time-phased, risk reduction fashion produces a product roadmap that shows the required technologies to support the demonstration (Figure 13). By creating these product roadmaps, the FLTC process orchestrates capability evolution expressed as attributes versus time.

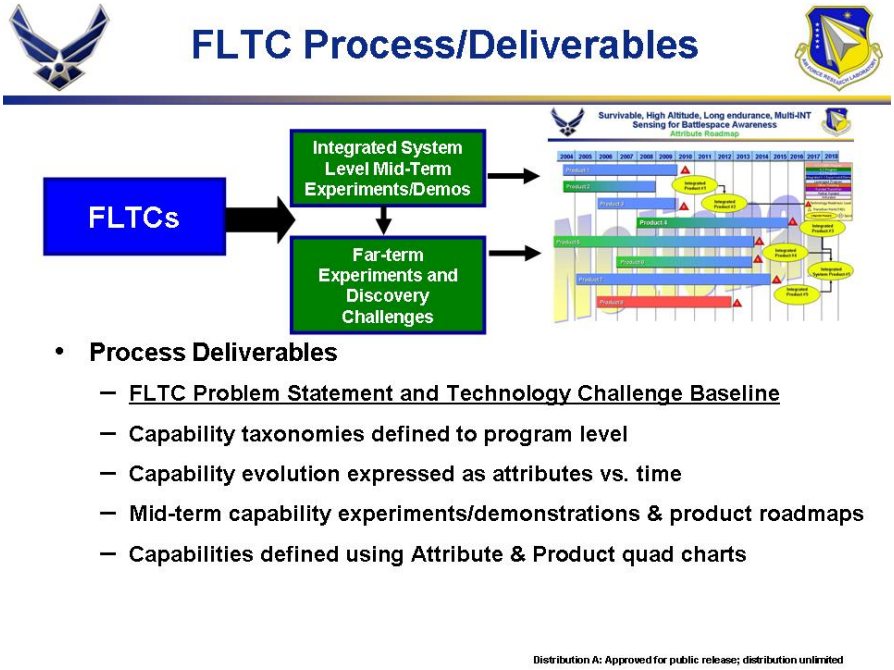

Fig. 13. FLTC Process.

2.3 FLTC Taxonomy

To describe this capability evolution process in a more succinct way, AFRL generated the FLTC taxonomy. The FLTC taxonomy provides the description of the process for breaking down the capability vision into manageable pieces that enable the technologist to look at research and development from both a mid-term and far-term perspective. Each FLTC is broken down into a series of problem statements that outline what must be solved to enable the realization of the capability vision captured in each FLTC. These problem statements are domain neutral to allow for maximum solution space.[4]

For each problem statement, there is a set of technology challenges that must be resolved for a game changing capability to be achieved and each challenge could have one or more scientific approaches. Each problem statement is broken down into a limited number of mid-term and long-term attributes, usually one mid-term and one long-term, and the attribute is associated with warfighting capability in a particular domain: air, space, cyber, or ground.

As for a mid-term attribute, AFRL has good understanding of which technologies are required to achieve the desired goal. The solutions to the mid-term attributes are achieved by integrating a number of products from one or more AFRL Technical Directorates to achieve the capability articulated by the attribute. Each product is then made up of a number of individual projects. Because the FLTC process breaks down the research and development of technologies to meet attributes to the project level, AFRL has direct insight into funding levels, risk, program timing, and milestone achievements.

In the case of a long-term attribute, AFRL may not know exactly how to solve the problem, so it requires a major breakthrough in the basic science to enable a viable solution to be further developed. This basic research is captured in the research area known as Discovery Challenge Thrusts (DCTs), managed by the Air Force Office of Scientific Research (AFOSR). Discovery Challenge Thrusts focus the research on the hardest problems that need to be solved to achieve the performance required by the attribute.

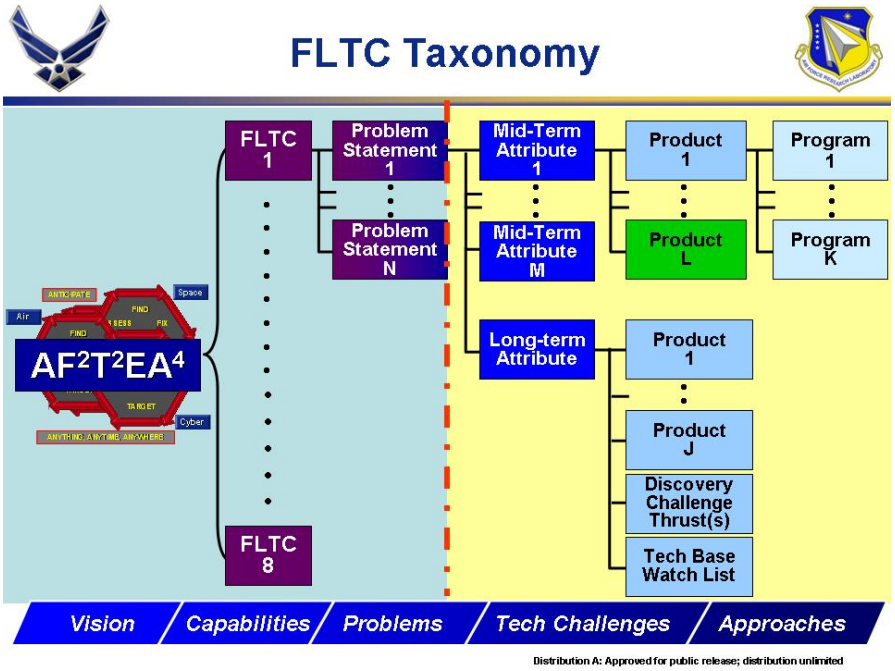

Fig. 14. FLTC Taxonomy.

This approach to breaking down the difficult visions serves multiple purposes. First, it makes the framework enduring. In other words, the problems do not change, but the solutions can. Second, it protects against those with problems dictating technical solutions, not that those solutions are incorrect, but, rather, that premature definition of a solution type effectively stifles innovation and potential breakthroughs in application of new/novel technologies. Third, it drives scientists and technologists to spend some time really understanding the operational problem, which further expands the potential solution space. Finally, because AFRL scientists, engineers, and project managers better understand the problems, it enables them to work more effectively with many sources of technology to meet customer needs.[5]

3. CONCLUSIONS

3.1 Investment Balance

AFRL must balance its investment program across several points of view: ensuring support for AF priorities, missions, and customers, while also balancing near-, mid-, and far-term focus. In the midterm, AFRL's principal technology graduation mechanism, an advanced technology demonstration (ATD) or a critical experiment, is designed to demonstrate technology maturity to the level of transition to an acquisition program. As the AF progresses on institutionalizing the FLTCs as the planning and execution structure, a much larger percentage of demonstrations will result from graduation of FLTC solutions to priority AF problems, providing a much greater opportunity for direct transition into needed programs and future AF capabilities.[5]

3.2 Impact of the FLTCs

This planning construct will have many positive consequences for the AF S&T program. It will drive AFRL to an integrated technology investment strategy, which will require time-phased synergistic technology development across multiple disciplines. It will provide an efficient and orderly investment build for Program Objective Memorandum (POM) inputs, including consequences and impacts to budget cuts. Finally, it will provide a mid- and long-term strategic planning window - a clear view into how AFRL is addressing AF future requirements and needs.

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